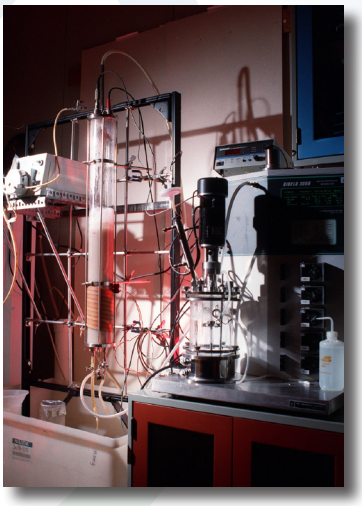
# Biotechnology for Oilfield Applications

The oil industry grapples with several production and environmental issues in recovering crude oil, including low oil production rates, water intrusion and production of "sour" fluids. These problems result in increased production and environmental costs. Scientists and engineers at Idaho National Laboratory (INL) are using microorganisms to provide economical solutions for the oil industry to address these production and environmental problems.

The low production rates of conventional technologies account for leaving nearly 60 percent of discovered oil unproduced. One of the most widely used technologies to increase oil recovery is waterflooding. Waterflooding entails injecting water to displace oil. The relatively high interfacial tension between oil and water, however, can result in significant quantities of oil being bypassed by the water. One solution to the problem is to apply *surfactants*.

Surfactants enhance oil recovery by reducing the interfacial tension at the oil and water interface. Reducing the interfacial tension improves oil displacement by reducing capillary force. Scientists at INL are researching the application of surfactants produced by microorganisms that will grow on process effluents from agriculture. Another solution to bypassed oil is to apply microbiological *polymers* to effect flow conformance. INL researchers are currently studying microbial products that interact with reservoir temperature and salinity parameters to correct flow conformance issues. Included in the study of microbial polymers are materials to prevent water shutoff. Water intrusion into oil wells results in the mixed production of oil and water. In successful treatments, water production decreases while oil production remains unchanged. Potentially, microbial processes have an economic advantage over chemical processes because they use inexpensive nutrients to produce plugging agents.



Sour fluids (oil, water and gas) are commonly defined by the presence of sulfides. Problems presented by sulfides include environmental compliance, toxicity, corrosion, reduced well performance, offensive odors, and reduced product value. These problems can result in very costly well shutdowns. Technologies to control sulfides including biocides, scavenging agents, corrosion inhibitors, Claus reactors, amine plants, etc., are available, but these technologies have problems. They are not very effective, use toxic chemicals, are costly and generate toxic wastes that require disposal. To overcome these problems, INL researchers are developing biocatalysis strategies that rely on bacteria to remove sulfides. Biocatalytic processes are less costly and are more environmentally acceptable because they use inexpensive, nonhazardous chemicals and generate low-toxicity products.

INL, Phillips Petroleum Company, and the University of Tulsa have performed collaborative research that effectively removes sulfides by applying biocatalytic processes.

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The Energy of Innovation

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## Selected Publications and Patents

**D. N. Thompson, S. L. Fox, and G. A. Bala,** "The Effect of Pretreatment on Surfactin Production from Potato Process Effluent by *Bacillus subtilis*," Applied Biochemistry and Biotechnology, Vol. 91–93, pp. 487–501, 2001.

**C. McComas, K. Sublette, G. Jenneman, and G. Bala,** "Characterization of a Novel Biocatalyst System for Sulfide Oxidation," Biotechnology Progress, Vol. 17, No. 3, pp. 139–446, 2001.

**S. L. Fox and G. A. Bala,** "Production of Surfactant from *Bacillus subtilis* ATCC 21332 Using Potato Starch, *Bioresource Technology,* Vol. 75, pp. 235–240, 2000.

**D. N. Thompson, S. L. Fox, and G. A. Bala,** "Biosurfactants from Potato Process Effluents," *Applied Biochemistry and Biotechnology,* Vol. 84–86, pp. 917–930, 2000.

**G. E. Jenneman, P. D. Moffitt, G. A. Bala, and R. H. Webb**, "Sulfide Removal in Reservoir Brine by Indigenous Bacteria," *SPE Production & Facilities,* Vol. 14, No. 3, pp. 219–225, 1999.

**S. P. O'Connell, R. M. Lehman, and G. A. Bala,** "Toxicological Evaluation of Hydrocarbon Removal by a Novel Remediation Process," *Spill Science and Technology Bulletin,* Vol. 4, Iss. 3, pp. 147–154, 1998.

**E. P. Robertson,** "The Use of Bacteria to Reduce Water Influx in Producing Oil Wells," SPE paper 37336, Proceedings of 1996 SPE Eastern, Regular Meeting, October 23–25, 1996, Columbus Ohio, pp. 129-135.

**G. A. Bala and C. P. Thomas,** "Apparatus for Removing Hydrocarbon Contaminants from Solid Materials," U.S. Patent 5,490,531, 1996.

**G. A. Bala and C. P. Thomas,** "Method for Removing of Organic Components from Solid Materials," U.S. Patent 5,454,878; 1995.

**C. P. Thomas, M. L. Duvall, E. P. Robertson, K. B. Barrett, and G. A. Bala,** "Surfactant-Based EOR Mediated by Naturally Occurring Microorganisms," *SPE Reservoir Engineering,* Vol. 8, No. 4, pp. 285–291, 1993.

**S. L. Eastman, M. A. Brehm, E. P. Robertson, J. D. Jackson, C. P. Thomas, and G. A. Bala,** "Comparative Analysis of Microbially Mediated Oil Recovery by Surfactants Produced by *Bacillus licheniformis* and *Bacillus subtilis*," in *Developments in Petroleum Science, Microbial Enhancement of Oil Recovery—Recent Advances,* E. Premuzic and A. Woodhead, eds., 1993, pp. 143–150

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